

5 TITLE: TRANSITION VALVING BY MEANS OF NON-RETURN
 VALVES

BACKGROUND OF THE INVENTION

10 A problem exists in gerotor motors when the valving
of the volume chambers does not match the volume change
in the volume chambers. For example, as one of the
volume chambers becomes a maximum volume transition
chamber, the valving of the unit will in some situations
15 continue to communicate high pressure fluid into that
volume chamber for some more degrees of rotation. The
instantaneous result will be that the volume chamber has
begun to decrease while still communicating with high
pressure. The valving then shuts off and the chamber
20 decreases further. Because of the overlap in the
valving, with no way to relieve pressure in the chamber,
the fluid pressure will rise rapidly creating a pressure
pulse or spike in that volume chamber. This incorrect
timing will result in a number of problems in the
25 gerotor, each of which will have a further detrimental
effect on volumetric efficiency and motor smoothness.
This problem is not specifically related to gerotor
motors, but occurs in all hydraulic machines having a
separate valving element.

30 It is therefore a principal object of this
invention to provide transition valving through the use
of non-return valves within the gear set of a gerotor
motor to correct the aforesaid problems.

 These and objects will be apparent to those skilled
35 in the art.

5 SUMMARY OF THE INVENTION

A rotary fluid pressure device has a first oil passage with relatively high pressure fluid therein surrounding the gear set; a plurality of second oil passageways connecting the first oil passageway to the
10 expanding and contracting oil chambers; and fluid non-return valves in each of the second oil passageways to permit the flow of oil therethrough only in a direction from the first oil passageway to the oil chambers.

15 DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic plan view of the gear set of this invention; and

Fig. 2 is a view similar to Fig. 1 but shows additional hydraulic circuitry.

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DESCRIPTION OF THE EMBODIMENTS OF THE INVENTION

Fig. 1 shows a first embodiment of the invention, not specifically related to a gerotor motor, but illustrated in gerotor motor 10. The motor 10 includes
25 a housing 12 containing the gear set 14, which includes ring member 16 and internal teeth (rollers) 18. A conventional star member 20 is located within ring member 16 and has teeth 22 and an internally splined opening 24. The numerals 26 and 28 are expanding fluid
30 volume members and contracting fluid volume members, respectively.

Those skilled in the art will understand that the designation of a volume chamber as "expanding" or "contracting" is in reference to its instantaneous,
35 temporary condition, and a particular volume chamber is in one or the other of those conditions for less than half of one orbit of the star 20. As is also well known

5 in the art, the interengagement of the teeth 18 of the
ring 16 and star 20 defines a minimum volume transition
chamber 28, and a maximum volume transition chamber 26.
As the names imply, the minimum volume transition
chamber 28 occurs when a volume chamber changes (is in a
10 "transition") from a contracting to an expanding volume
chamber, and is at, or very near, its minimum volume.
This occurs once for each volume chamber during each
orbit of the star 20. Similarly, the maximum volume
transition chamber 26 occurs when a volume chamber
15 changes from an expanding to a contracting volume
chamber, and is at, or very near, its maximum volume.
This also occurs once for each volume chamber during
each orbit of the star 20.

The gear set 14 (Fig. 1) with the star member 20
20 and ring member 16 and seven rollers 18, is supplied
with the oil connection 30 from each volume chamber 26
and 28 to a common oil passage in or in connection with
the gear set. Via a high pressure select valve 36, this
oil passage 34 is connected to the A and B ports of the
25 motor, meaning that the highest pressure supplied to the
motor will always act in the oil passage 34. The
contracting chambers 28, connected to the motor outlet
connection, will be exposed to a low pressure, and the
non-return valves 32 will thus be closed. The expanding
30 chambers 26, connected to the motor inlet condition,
will be exposed to a high pressure. As the oil passage
34 is also exposed to the same high pressure, the non-
return valve 32 might be open or might be closed. This
is of no significance for the operation of the motor, as
35 high pressure is high pressure no matter through which
passage it is connected to the chamber.

5 Contracting chambers 28, neither connected to the
inlet, nor to the outlet of the motor, are of concern.
Trapped oil in these chambers will connect to the oil
passage through the non-return valves 32, as soon as the
pressure rises above the high-pressure level. Pressure
10 peaks will thus be avoided.

Fig. 2 shows the gear set of Fig. 1, and show in
addition a schematic view of the valving of the motor.
Each volume chamber of the gear set is connected through
a passage 38 with the valving 40. (Only two of the
15 connections are shown.) In these two passages 38, a
pilot operated check valve 42 is placed, meaning that
flow from valving 42 to the gear set 14 is always
possible, and flow from gear set to the valving 40 is
selectively on or off.

20 Check valve 32 will communicate fluid from the
volume chambers 28 to the fluid passageway 34, when the
oil pressure in a volume chamber 28 rises above the
level of pressure in the fluid passageway 34. This will
be the case, when ordinary valving to a contracting
25 volume chamber is shut off, whereby fluid will be
trapped in the chamber and compressed due to the
contraction. As the pressure in the contracting volume
chamber reaches the level of pressure in the fluid
passageway 34, further compressing of the fluid is
30 avoided, and thus pressure peaks are avoided.

Check valve 42 is a controlled on/off valve between
ordinary valving 40 and volume chambers 28. When this
valve is open, the valving of the motor will communicate
with all volume chambers, and the function of the motor
35 will be normal. If one of the valves 42 is closed,
fluid communication between ordinary valving 40 and this
volume chamber will only be possible when the pressure

5 from the valving is higher than the pressure in the
volume chamber. This means that fluid will be
communicated from the valving to the volume chamber when
it is expanding, but not when it is contracting. Fluid
from the volume chamber will, when it is contracting, be
10 compressed, and thus led to the fluid passage 34 through
check valve 32.

Passageway 34 is communicating with the high-
pressure inlet to the motor, whereby fluid will be
returned to the motor fluid inlet. The volume chamber
15 is basically idling, whereby fluid consumed during
expanding is returned during contracting. The number of
working volume chambers is thus reduced, whereby the
displacement of the motor is reduced. Lower
displacement means higher revolution at lower torque,
20 when pressure and flow across the motor is maintained.

Having only one volume chamber supplied with a
valve 42 gives the possibility of shifting between two
different displacements. Having two volume chamber
supplied with a valve 42 gives the possibility of
25 shifting between three different displacements, having
three gives four different displacements and so on.

When the pilot operated check valves 42 are open,
oil communication between gear set 14 and valving occurs
like in an ordinary motor. However, when the pilot
30 operated check valve 42 to a volume chamber is closed,
this chamber will be unable to communicate oil from a
contracting chamber to the valving, and further to the
outlet of the motor. Instead, oil in the contracting
chamber 28 will be compressed and consequently led to
35 the oil passage through the non-return valve 32 for that
chamber. Thus oil in a contracting chamber 28 is
returned to the high-pressure side, and the displacement

5 of the gear set will be reduced. Closing the pilot
operated check valves 42 in more than one passage 38
between gear set and valving will further reduce the
displacement of the motor. It is thus possible to make
a step-wise adjustment displacement, which will
10 correspond to a stepwise adjustable motor speed and
torque, for equal pressure and flow conditions for the
motor.

U.S. 6,033,195 discloses a two-speed gerotor motor,
where a sliding valve changes the oil flow between
15 inlet/outlet and valving. This means that all volume
chambers in the gear set will be interfered by shifting
between two displacements, like in all known two-speed
applications for gerotor motors. With the arrangement
of Fig. 2, only the volume chamber connected to the
20 pilot operated check valve 42 will be exposed to the
shift in displacement, and not all the others chambers.
Shifting with a running motor is thereby made much
easier.

The shifting operation could be controlled in a
25 time sequence, if the motor has more than one passage
with a pilot-operated check valve. Shift from highest
displacement to lowest displacement will thereby always
occur stepwise, when the motor is running.
Additionally, shifting of each pilot operated check
30 valve could occur in a pulse modulated way, whereby the
change in displacement will correspond to a ramp
function, instead of a step function.

The instant invention focuses on the non-return
valves 32 and the oil passage 30 in connection with the
35 gear set 14. Additionally, this invention can be used
in a multiple displacement motor, by adding the pilot-
operated check valves 42. It is therefore seen that

5 this application will achieve at least its stated objectives.